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(71) Applicant
Drexler Technology Corporation

(Incorporated in USA-California)

3960 Fabian Way, Palo Alto, California 94303, United States of America

(72) Inventors
Richard Haddock
Joseph B Arnold
Jerome Drexler

(74) Agent and/or Address for Service
D. Young & Co
10 Staple Inn, London, WC1V 7RD

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US 4572891 US 4544835

(58) Field of search
B6A

(54) Method for forming data cards with registered images

(57) Data cards are formed by writing a succession of latent images on a first web (13) of photosensitive film, developing (25) the film and then joining the film (13) with a web (31) of high resolution laser optical recording tape. The webs, (13, 31) may be joined in either back-to-back or front-to-back relationship. In the first case there is an eye readable image on one side and formatted optical recording tape on the opposite side. In the second case an eye readable image is optically adjacent optical recording tape, but on different layers, with both readable from the same side through a transparent substrate or base. The composite web is cut transversely (53) to its lengthwise dimension into a plurality of wallet size members (55). Bar code is recorded together with the latent image so that in checking cards for quality control purposes, defective cards may be correlated with particular images in order that a defective card be recreated. The high resolution optical recording tape is preformatted with continuous servo tracks or data location grids without header information so that registration of the eye readable images and the laser recording tape is not necessary.

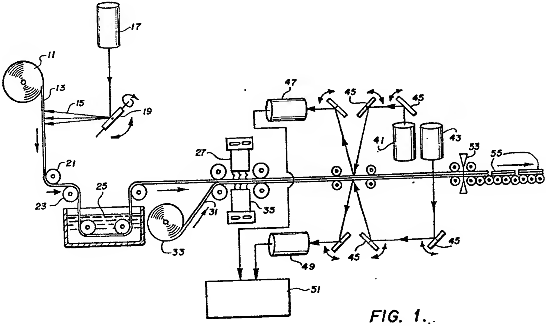

FIG. 1.

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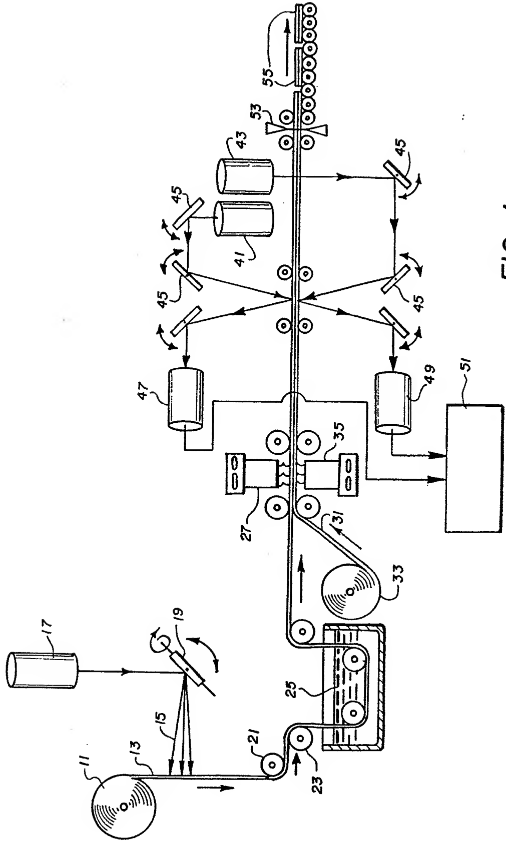

FIG. 1.

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FIG. 2.

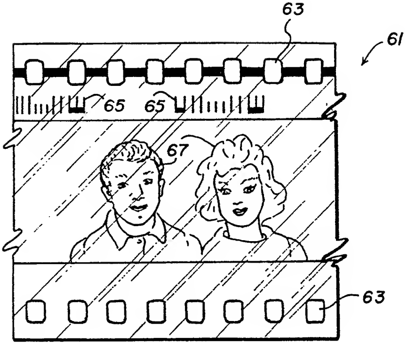
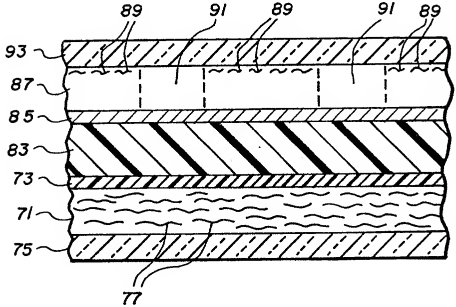


FIG. 3.



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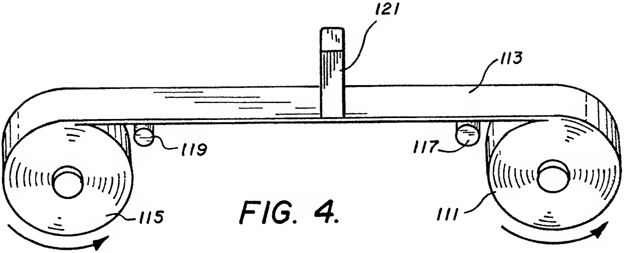


FIG. 4.

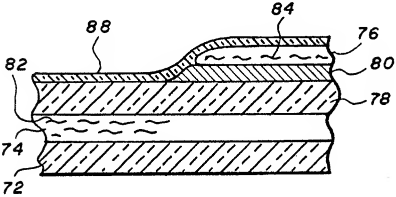


FIG. 3a.

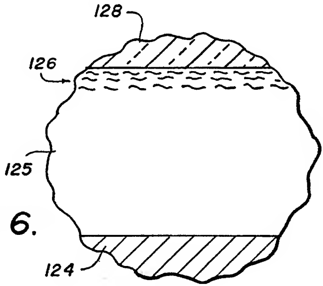
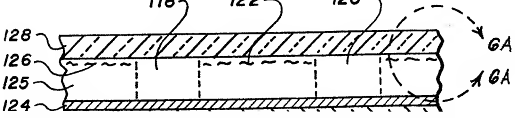


FIG. 6.

FIG. 5.



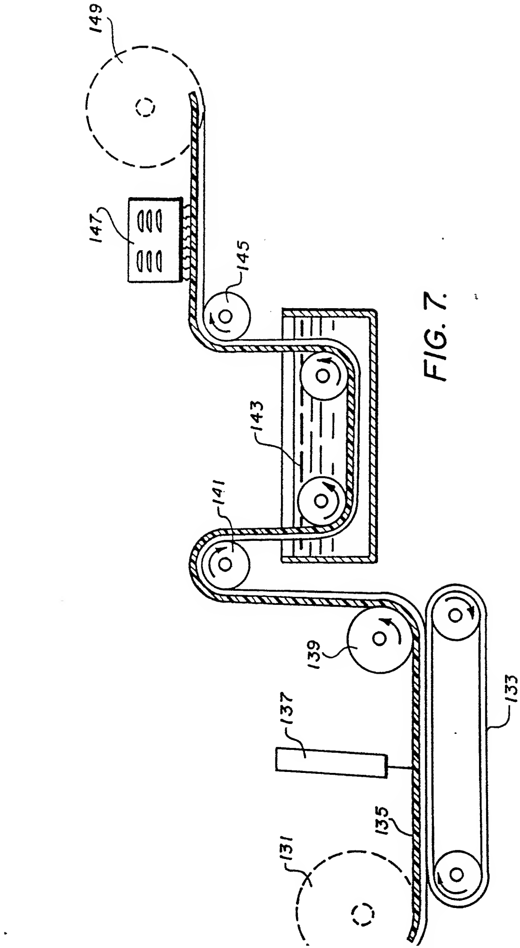


FIG. 7.

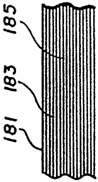


FIG. 8.

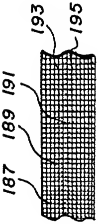


FIG. 9.

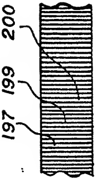


FIG. 10.

FIG. 11.

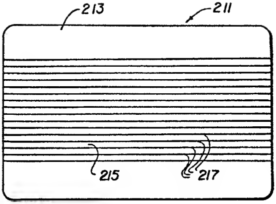
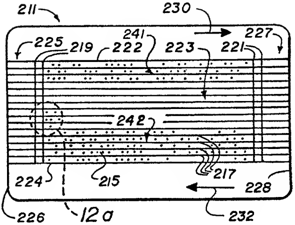


FIG. 12.



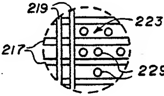


FIG. 12a

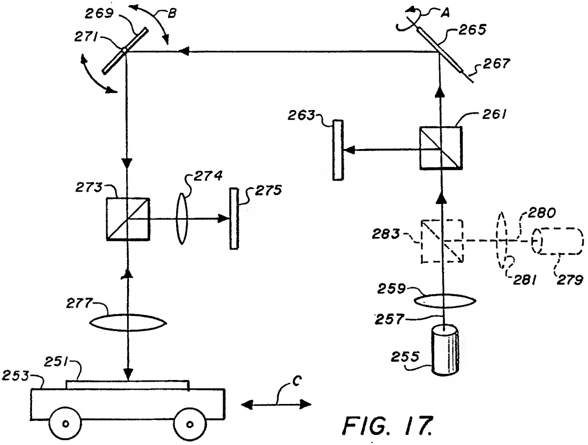


FIG. 17.

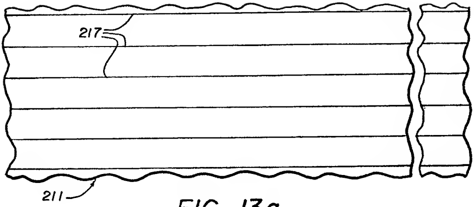


FIG. 13a.

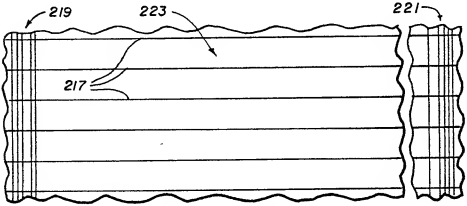


FIG. 13b.

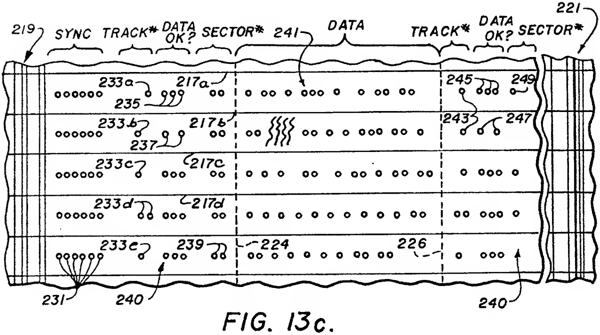


FIG. 13c.

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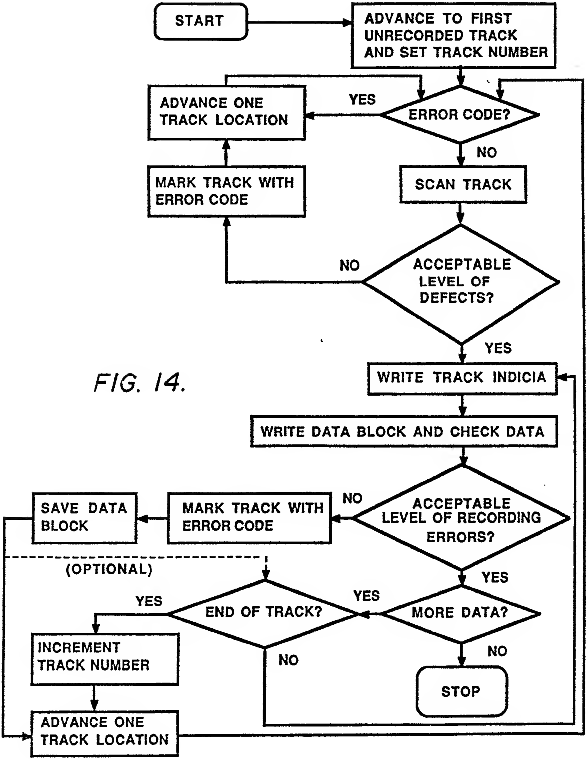
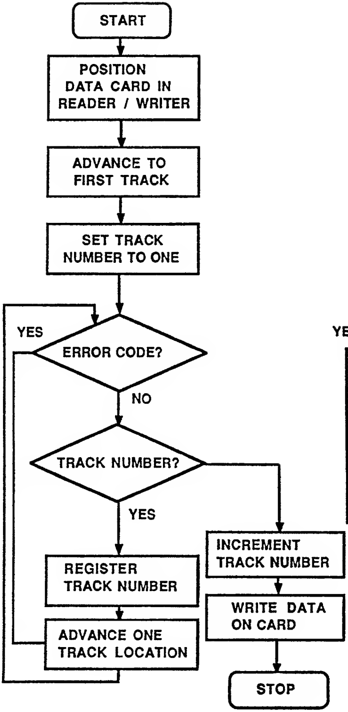
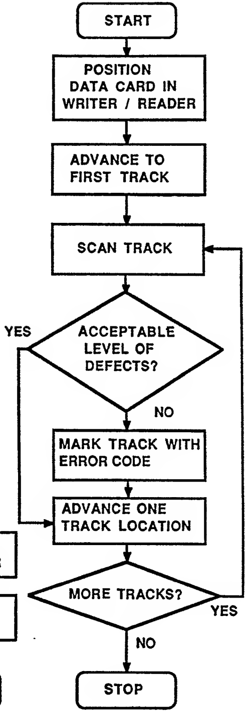


FIG. 14.



START
POSITION DATA CARD IN READER / WRITER
ADVANCE TO FIRST TRACK
SET TRACK NUMBER TO ONE
ERROR CODE?
YES
NO
TRACK NUMBER?
YES
REGISTER TRACK NUMBER
ADVANCE ONE TRACK LOCATION
INCREMENT TRACK NUMBER
WRITE DATA ON CARD
STOP

FIG. 15.



START
POSITION DATA CARD IN WRITER / READER
ADVANCE TO FIRST TRACK
SCAN TRACK
ACCEPTABLE LEVEL OF DEFECTS?
YES
NO
MARK TRACK WITH ERROR CODE
ADVANCE ONE TRACK LOCATION
MORE TRACKS?
YES
NO
STOP

FIG. 16.

METHOD FOR FORMING DATA CARDS WITH REGISTERED IMAGES

The invention relates to data cards.

Identification cards have used magnetic data strips in conjunction with photographs of the card holder.

USA Patent Specification No. 4 236 332 discloses a medical record card containing a microfilm portion having some data visible to the eye and other data is alphanumeric character codes pertaining to emergency medical conditions of the patient and the magnifiable data portions detail the medical history.

UK Specification No. 2 044 175 discloses a card having eye readable, machine readable and security verification information. The machine readable data may be laser recorded or magnetic data.

USA Patent Specification No. 4 213 038 discloses an access control system with an identification card. The card has machine recordable indicia used to choose a master microspot pattern from the machine's memory. This master pattern is compared with an identical pattern on the card for verification. The card also has space for a picture and a signature. Similarly, USA Patent Specification No. 4 151 667 discloses an identification card having a photograph and a phosphorescent bar code pattern used for verification.

The amount of information these cards can hold is extremely limited. Data visible to the eye occupies a considerable amount of space on a card, which further limits the amount of information that can be stored. In USA 4 151 667 the photograph and bar code pattern overlap. Random microspot patterns can only be used for verification, while bar codes can only represent a small amount of specific data.

According to one aspect of the invention there is provided a method of forming a wallet size data card comprising,

reproducing a plurality of visible images on a first web from a roll, the first web having a front side, a back side and a width dimension not exceeding the width dimension of a wallet size card, the length of the visible image not exceeding the length dimension of a wallet size card.

forming a second web from a roll of high resolution laser optical recording tape containing servo tracks or data location grids, the

second web having a front side, a back side and a width dimension, joining the first web to the second web with one side of the first web proximate to a corresponding side of the second web, and cutting the joined web at intervals along the lengthwise dimension thereof into a plurality of wallet size cards, each card having a visible image and optical recording tape.

According to another aspect of the invention there is provided a method of forming a wallet size data card comprising, writing a succession of latent images containing picture information with a scanning laser onto a first elongate web of photosensitive film, the first web having a front side and a back side, advancing the web and developing the latent images into a succession of eye readable pictures, joining a second elongate web of high resolution laser optical recording tape with the first web, the second web having a front side and a back side, the two webs being jointed with one side of the first web proximate to a corresponding side of a second web, thereby forming a composite web, and cutting the composite web transversely into lengths forming wallet size cards, each card having an eye readable picture portion and an optical recording tape portion.

According to yet another aspect of the invention there is provided a data card comprising, a card substrate having front and back opposed major surfaces and a length and width comparable to wallet size bank cards, a high resolution DRAW optical recording material applied to a first surface portion of the card, a recording medium carrying a visible image applied to a second surface portion of the card, and a low resolution machine readable scanner coding strip applied to a third surface portion.

Thus a data card can be formed by merging two webs, one from a roll containing visible images, and one from a roll containing pre-formatted high resolution optical recording material. As the two webs are merged, they are joined together and then cut to card length, with eye readable and machine readable images disposed in back-to-back relationship. Alternatively both types of data could be read from the

same side. The eye readable image contains a machine readable identifier so that automatic optical inspection and acceptance may be performed on finished cards. If such an inspection reveals flaws or data errors, the image is identified by the machine readable data and may be re-recorded for a second attempt to make the card. In this manner, the merger of two webs, and subsequent cutting, provides an opportunity for precise registration in forming large numbers of data cards and the remaking of only those cards which failed inspection.

The invention is diagrammatically illustrated by way of example in the accompanying drawings, in which:-

Figure 1 shows a manufacturing method for making data cards according to the invention;

Figure 2 shows a film segment employed in the card manufacturing method shown in Figure 1;

Figure 3 is a cross sectional view of a double sided card with eye readable and machine readable images on opposite sides;

Figure 3a is a cross sectional view of a single sided card with eye readable and machine readable images on the same side of the card;

Figure 4 is a perspective plan view of tape rolls spooling optical recording tape employed in the method of the invention;

Figure 5 is a side sectional view of the optical tape of Figure 4;

Figure 6 is a detail magnified from the area indicated by line 6a-6a in Figure 5;

Figure 7 is a side view of apparatus for forming the optical tape of Figure 4;

Figures 8 to 10 are views of portions of strips of optical recording tape, showing prerecorded servo track guides disposed on the tape in various directions;

Figure 11 is a view of a data card with optical tape mounted thereon, showing prerecorded tracks;

Figure 12 is a top plan view of the card of Figure 11 with initialized stop and start marks;

Figure 12a is an enlarged view of a portion of the card shown in Figure 12;

Figure 13a, 13b and 13c are schematic views of data tracks at various stages of recording;

Figure 14 is a flow chart illustrating a method of recording data on the card of Figure 11;

Figure 15 is a flow chart detailing steps for advancing to a first unrecorded track and setting the track number in accord with the method of Figure 14;

Figure 16 is a flow chart illustrating a method of recording data on the card of Figure 11 and checking for defects in that card; and

Figure 17 is a simplified plan view of a system for reading and recording on the data card in Figure 1.

With reference to Figure 1, a supply roll 11 provides a continuous web 13 of unexposed, undeveloped photographic film. The film is moved from the supply roll 11 past a recording beam 15 derived from a beam source such as a laser 17, and a scanner 19 which sweeps the beam 15 across the film in a scanning fashion, reproducing an image. Such film recorders are known and typically reproduce digitally recorded images. In this manner, a data base having a large number of images may produce a series of pictures as output and each picture is transferred to film, as needed. Images are to be mounted on cards and so the sequence of images corresponds to a sequence of cards to be produced. Such a situation arises in production of identification cards, drivers licences, student registration cards and the like. Together with picture data, low resolution machine readable indicia, such as bar code, are also recorded for subsequent use in quality control.

The film web is advanced by means of edge sprockets or friction rolls 21 and 23 which feed the film into a film developing and processing bath 25. After the film web is developed and dried by a heater 27 the film web is merged with a web 31 of preformatted high resolution laser, direct-read-after-write (DRAW) optical recording tape from a supply roll 33. The optical recording tape has approximately the same lateral dimensions as the film. the recording surface of the tape is disposed in either front-to-back or back-to-back relation with the film. The two may either be thermally bonded using the heater 27 and a heater 35, or may be adhesively joined. The formatting of the optical data tape is discussed below. If the webs are joined back-to-back, film and data are read from opposite sides of the composite web as discussed with reference to Figure 3. If the

webs are joined front-to-back, film and data are read through one of the substrates on the same side and the images must be laterally separated as discussed below with reference to Figures 3a.

The tape or the film, or both, carries a backing member which when joined to the other forms a self-supporting structure which will be subsequently cut into cards. After joinder of the two webs 13, 31, the film and data web portions undergo quality control scanning by laser scanners 41 and 43. Each scanner has associated scanner mirrors 45 for areawise simultaneous reading of front and back sides of the card. A detector 47 receives the image from the laser 41 while a detector 49 receives the image from laser 43. The image which has been scanned by the laser 47 should correspond to the image originally recorded by the film recording laser 17. The detector 49 checks for the presence of prerecorded formatting on the high resolution laser recording material.

A computer 51 receives data from the scanners and notes any failures, such as lack of an image, or lack of data tracks. In this situation, the computer may order a re-recording of the eye readable information. Since the preformatted high resolution laser optical recording tape is continuous preformatted web of similar material, no re-recording is necessary. Advancement of the supply roll will provide a new portion to receive a re-recorded visual image and once again attempt to form a proper back-to-back combination which will pass inspection. After inspection, the joined webs pass to a cutter 53 which forms individual data cards 55.

Figure 2 shows the upper surface of a film web portion 61 having opposite sprockets holes 63 for advancement and machine readable indicia 65 which are used to identify the face photographs 67 during quality control review. The sprocketted holes are shown for illustration and unsprocketted film is preferred. The indicia 65 are low resolution machine readable code, although high resolution indicia may also be used. The film shown in Figure 2 is similar to common 35 mm film except that the machine readable indicia are on the inside of the sprocket holes, rather than on the outside. This is because if they are used the sprocket holes may be trimmed away after joinder with the machine readable web portion. Note that precise registration is not needed since the high resolution optical recording tape is

continuously formatted.

In Figure 3, the cross section of the joined webs may be seen to comprise a first emulsion layer 71 having filamentary silver particles 77 therein, characteristic of developed silver halide films. The emulsion layer 71 is adhered to a Mylar substrate 73 and has a protective coating 75 disposed over the emulsion. The layers 71, 73 and 75 comprise the photographic film web portion which is joined to the laser recording material.

The preformatted high resolution laser recording tape may comprise a Mylar substrate 83 which may be coated with a very thin metal layer 85. The layer 85 is used to enhance the optical contrast of the laser recording tape. Disposed over the thin metal layer 85 may be an emulsion layer 87 which has regions of one reflectivity characterized by metal particles 89 and regions of a second reflectivity 91, indicated by vertical dashed lines, which are prerecorded and which expose the highly reflective metal layer 85 which is more reflective than the region wherein the metal particles 89 reside. A transparent coating 93 is applied over the recording layer. Other preformatted or unformatted laser recording tapes known in the art may also be used.

With reference to Figure 3a, the cross section of the joined webs comprises a first web having a film substrate 72 and a photographic emulsion coating 74 extending across the lateral extent of the substrate. A picture does not occupy the full lateral extent because room is left in a field of view from one side of the card for a superposed strip of optical recording material 76 carried by a Mylar substrate 78 forming the second web. The first and second webs are joined together such that the emulsion 74 and the optical recording material 76 are optically in side by side relationship. The optical recording material may be of the kind described below with reference to Figures 5 and 6. A protective transparent cover layer 88 may be disposed over the recording medium 76. A thin reflective metallic layer 80 is disposed between the optical recording material 76 and the substrate 78 to enhance optical contrast. the emulsion layer 74 is seen to contain filamentary silver particles 82, characteristic of developeo silver halide films. The optical recording material 76 contains metal particles 84 whose reflectivity may be altered by a

laser beam. Contrast is enhanced by means of the metallic layer 80. Both the photographic image in the emulsion 74 and the optical data in the recording material 76 may be read from the same side. In this situation, reading optics for both the film and the recording material would exist on the same side of the joined webs.

With reference to Figure 4, a supply tape hub 111 is seen dispensing a tape web 113 to a tape take-up hub 115, the tape passing around turning or support posts 117 and 119. The tape web 113 is an optical recording medium capable of laser writing. The tape has a width ranging from 1 cm to 5.5 cm and is relatively thin, about 400 microns or less, although this is not critical. The tape web 113 is typically about 300 metres long. A linear laser array 121 of semi-conductor diode lasers records parallel, spaced-apart servo tracks on the tape by displacing, modifying or agglomerating absorptive metal particles in the tape medium. Alternatively, a single laser emitting a beam that repeatedly scans laterally across the tape as the tape is advanced past a scanning station may be used. A writing system guides the laser beam so that data are written or read in parallel paths. It is important that parallelism be maintained accurately, so a mechanical alignment mechanism, not shown, may be used to ensure that the position of the tape passing in front of the laser array 121 is proper. Moreover, all portions of the tape should experience uniform lateral tension so that the tape is not squeezed together between its opposite edges.

The tape path illustrated in Figure 4 is a very simple path with drive power being applied directly to one of the hubs 111, 115 by a transport mechanism. The tape may be reversed in direction of travel by applying power to the opposite hub. The hubs may be driven directly by motors or by belts attached to pulleys in power communication relation to the hubs. Sometimes more complicated systems of posts and tape paths are used for high-speed tape transport. Typically, tape may be advanced in either direction at a rate of about 5 metres per second. A read head could be combined with the laser bar writing mechanism 121 to form a read/write system. The read head would comprise a number of photo diodes or CCD elements in a linear array, spaced similarly as the laser array 121, except being vertically movable, as by a servo controlled piezoelectric element in

order to maintain the read elements in a data path following position so as to confirm the writing.

The recording material which is selected should be compatible with the laser used for writing on it. Some materials have a higher recording sensitivity than others at certain wavelengths. Good recording sensitivity to near-infrared light is preferred because semi-conductor lasers creating the required light beams are readily available. The selected recording material should have a favourable signal-to-noise ratio and form high contrast databits with read/write systems with which it is used. The material should not lose data when subjected to temperatures of about 60°C (140°F) for long periods. The material should also be capable of recording at speeds of at least several thousand bits per second. This generally precludes the use of materials that require long heating times or that rely on slow chemical reactions in the presence of heat, which may permit recording of only a few bits per second.

With reference to Figures 5 and 6, one example of the optical recording media comprises a film substrate layer 123, a highly reflective metallic layer 124 deposited on the substrate layer 123 and a selected, thin black silver planar crust 126, generally less than one-half micron thick, within a gelatin layer 125. The gelatin layer 125 is generally one to six microns thick, disposed on the metallic layer 124, which is generally 100 Angstroms to 1000 Angstroms thick. During the optical medium manufacturing process the surface of the silver-halide emulsion, distal to the substrate, is developed to dark or black by exposure to actinic radiation and then to photographic development. Black and clear images can be created if desired by using a photomask. The exposing image is a pattern of control indicia such as tracks or data location grids to be pre-recorded. The depth of the dark layer is typically 0.3 to 0.5 microns. The undeveloped remainder of the emulsion layer which is essentially gelatin remains clear. Other laser recordable tapes known in the art may also be used. The substrate layer 123 should be self-supporting, yet sufficiently flexible for the tape to be spoolable, i.e. so that a length of tape may be wound on a tape hub. A transparent, planar protective layer 128 may be disposed over the laser recording layer 126. Polycarbonate plastics material is one of the preferred

materials for the layer 128 and may be a thin laminating sheet adhered over the tape or, alternatively, other clear plastics or a lacquer coating may be used.

The film substrate layer 123 may be composed of polyesters, cellulose acetate, Mylar, or other materials commonly used as film bases. The metallic layer 124 is typically composed of either gold, copper, silver, aluminum or alloys thereof and may be 100 to 1,000 Angstroms thick.

The gelatin layer 125 originally was the gelatin matrix containing a silver halide emulsion, i.e. a photographic emulsion layer. the gelatin colloid matrix should be made from material which is substantially transparent to a read beam wavelength in the near infrared, and may be further selected to be substantially more absorptive at an actinic wavelength thereby enhancing the antihalation properties of the recording medium during the preformatting process. The gelatin layer 125 is typically under 3 microns thick, but could be as thick as 10 microns. The gelatin layer 125 containing the crust 126 is shown having been exposed to actinic radiation and then developed to be substantially dark only at its surface. Wavy lines in the planar crust 126 represent black filamentary or oblong silver particles embedded in the gelatin colloid matrix.

Areas 118 and 120 represent data spots which have been laser recorded by displacement, modification and/or agglomeration of metal particles in the crust 126 to be predominantly clear, revealing an underlying reflectivity in the metallic layer 124 when illuminated by light of a read beam wavelength, typically in the near infrared. The areas 118, 120 are preferably sharply defined, rather than diffuse or otherwise blurred. The optical density of background areas 122 at the read beam wavelength of the gelatin layer 125 should be at least 0.5 and preferably greater than 1.0. The optical density of the spot areas 118, 120 of the gelatin layer 125 should be not more than 0.2 and preferably less than 0.1.

The metallic layer 124 is placed onto the flexible self-supporting film substrate 123 by vacuum or vapour deposition and then applying the thin, planar photosensitive emulsion layer 125 over the reflective metallic layer 124 or alternatively a thin photosensitive emulsion layer over a gelatin layer covering a reflective metallic

layer. Alternatively, the thickness of the laser sensitive recording layer can be controlled in the manufacture of the photosensitive starting material.

Very thin (0.25 - 0.5 m) photosensitive silver halide emulsion can be coated over clear gelatin to achieve the thin recording layer. The resulting photosensitive web is then processed by exposure, development and fixing, as described in greater detail below, to produce a laser sensitive, but not photographic sensitive medium. Track guides and other control indicia may be photolithographically prerecorded during the processing of the photosensitive web, if desired, by imagewise exposure through a mask. The planar, transparent protective layer 128 may finally be adhered over the optical storage layer 125. To simplify registration with the photographic images only the track guides would be recorded.

Figure 7 illustrates photographic processing for producing a laser sensitive optical tape medium from a photosensitive web 135. The photosensitive web 135, stored on a reel 131, is driven by a tape advancing mechanism 133 beneath a source 137 of actinic radiation. The source 137 may be a laser bar or other source of green, blue or ultraviolet light which illuminates the web surface. Typically, the actinic light has a wavelength in the blue-green range of 0.4 to 06. microns, although ultraviolet light with wavelengths less than 0.4 microns may also be used. The web 135 is thus exposed to create a latent image. The entire mechanism in Figure 7 is shielded in a protective housing which preserves the light sensitive character of the web 135.

An emulsion layer is preferably a fine grain silver-halide emulsion in a gelatin matrix. The smaller the grain sizes of the silver-halide emulsion, the higher the resolution of the final pre-recorded product. The emulsion grain size should be less than 5% of the recording data spot size for best results, and emulsions with grain size on the order of 0.05 microns are commercially available. Antihalation dyes, also known as attenuating or accutance dyes, may also be added to the photographic emulsion to increase the absorptivity of the emulsion at the actinic wavelength thereby concentrating the exposure to the top surface of the emulsion. This can help create a thin black recording crust. It can also reduce any

halation effect and give higher resolutions. Such dyes are commonly used and are water soluble and thus are not present when the emulsion has been converted to the optical storage media.

If pre-recording of track guides is desired, a shielding mask may be placed over the unexposed web 135. The mask would typically have two degrees of transmissivity to actinic radiation, being substantially clear over most of its extent, except for an imagewise pattern of optically dense lines for forming track guides.

Idlers 139 and 141 advance the exposed tape web into a processing solution 143 where the web is developed and fixed. Additional tanks, not shown, are used for this process. Exposure of the web 135 to actinic radiation creates a latent image in which silver halide is activated substantially to saturation. The exposed web is developed to produce a medium which is substantially dark over most of its extent, but which may have an imagewise exposure pattern of partially clear track guides revealing the underlying reflectivity in the metallic layer for light of read beam wavelength. Development of the surface layer may be a surface development occuring typically within the top 0.3 to 0.5 micron of the emulsion layer in a plane distal from the substrate. Such development occurs by contacting the light exposed image layer with a concentrated development solution for a very short period, before the development solution can diffuse into the material or by means of a slow-diffusing developer such as tertiary butylhydroquinone.

Alternatively, a viscous developer thickened with carboxymethylcellulose may be used. This material is syrupy in consistency and is rolled on. It may be washed off and development stopped with a spray stop bath. It then is treated with a fixing bath. Crusts as thin as five to ten percent of the thickness of a ten to fifteen micron emulsion layer have been made. During development, areas containing black filamentary or oblong silver particles are formed from activated silver-halide areas. The volume concentration of activated silver halide at the emulsion surface determines the volume concentration of filamentary silver, which in turn determines the optical density of the emulsion layer. Areas containing filamentary silver should exhibit an optical density as measured with red light of a photographic densitometer of at least 0.5 and

preferably greater than 1.0, while any unexposed track guide areas should have densities less than 0.2. Subsequent to development, fixing and rinse steps remove the remaining silver halide from the emulsion layer 135 leave just silver in the gelatin matrix.

The web is advanced past an idler 145 and beneath a drying unit 147 after processing has converted it into an optical recording material. The laser sensitive medium is then wound on a takeup hub 149 and stored for future use.

Figures 8-10 show the placement of servo track guides on an optical tape. In Figure 8, track guides 181, 183 and 185 extend longitudinally parallel to the lengthwise direction of the tape web. the track guides are spaced apart at least wide enough to accommodate data spots between the guides, although several writing areas could be associated with one track guide. As an example, the track guides may be 10 microns apart, with data spots having a size of three microns between the guides and a servo track guide line width of three microns.

While lengthwise servo tracks are preferred, it is also possible to have side-to-side servo tracks. As seen in Figure 10, track guides 197, 199, 200 are again parallel, but transverse to the lengthwise direction of the tape. Such tracks are known as lateral tracks, to distinguish them from the lengthwise tracks previously described. Lateral tracks consist of parallel, closely spaced tracks with a line-to-line separation, approximately the same as for longitudinal tracks. The spacing must be sufficient to accommodate a data path between adjacent tracks or in some relation to a track, such as overlying it, with enough room for adjacent paths.

Lateral data paths would be written by a scanning laser which sweeps across the width of the tape as the tape is advanced past a scanning station. In the read situation, data could be detected by a linear array of detector elements, such as a CCD array. An adjacent servo track, if any, would be detected when a continuous line is observed by the array. The linear array would be aligned parallel to the servo tracks with tape motion synchronized with detector electronics, allowing the detector array a sufficient time to observe a pattern on the tape as the tape advances past the detector array. The tape need not stop for observation, but may move continuously past

the detector array.

In Figure 9, the track guides run in two perpendicular directions. For example, guides 187, 189 and 191 extend longitudinally parallel to the lengthwise direction of the tape web while guides 193 and 195 are aligned laterally, i.e. transverse to the direction of the tape web. In this case, a read system could follow either set of guides or treat the guides as forming a data location grid in which data are written in relation to the grid, either on the lines or tracks, or inside of the rectangles formed by the tracks. Data could be located by counting line crossings from marked reference positions. The grid pattern could also be used as a reference guide when strips of the tape are used for laser recording of data. The grid pattern forms can be used for alignment of data spots.

The final result of these processing steps is a superior laser recording medium comprising a very thin black silver crust within one of the planar surfaces of a gelatin layer and a reflective underlayer which achieves good recording sensitivity, high contrast and resolution for laser recording of data. Laser recording on this medium is efficient, because the filamentary silver particles in the crust are absorptive causing a rise of temperature at the top surface of the crust, thereby facilitating the particle modification, displacement or agglomeration of the crust layer. Also, since the crust is thin, very little time is required for the laser beam to modify the crust to reveal the reflective metallic layer beneath the gelatin layer. These filamentary particles are absorptive of light energy over a very wide spectrum range from ultraviolet to near infrared, permitting a wide variety of lasers to be used for recording.

With reference to Figure 11, a data card 211 comprises a card base 213 and a strip 215 of laser recordable optical data storage tape disposed thereon. The photograph of Figure 2 is on the opposite side of the card 211 and is not shown. A plurality of generally parallel tracks 217 are prerecorded on the strip 215 by laser or photolithography. The data card 211 is preferably a wallet size card with a width dimension of approximately 54 mm and a length dimension of approximately 85 mm. These dimensions are not critical, but preferred because such a size easily fits into a wallet and has been

adopted as a conventional size for automatic teller machines and the like. The card base 213 is a dielectric, usually a plastics material, such as polycarbonate, polyvinylchloride or similar material. The card base 213 may be either opaque or transparent but should have low specular reflectivity, preferably less than 10%, when used with strips 215 which are reflective media. The card base 213 must be transparent when used with strips 215 which are transmissively read. The strip 215 is typically about 10 mm to 35 mm wide and extends the length of the card. Alternatively, strip 215 may have other sizes and orientations. The strip may be applied by any convenient method which achieves flatness and adherence to the card base. A transparent protective laminating sheet made of polycarbonate plastics or other material may cover the strip 215 to protect it from dust and scratches.

The laser recordable optical data storage material which forms the strip 215 may be one of the reflective recording materials which have been developed having direct-read-after-write capability. Many such materials are known in the art. Typical recording media used by the assignee are described in USA Patent Specification Nos. 4 314 260, 4 278 758, 4 278 756, 4 298 684, 4 269,917 and 4 284 716. These media contain suspensions of reflective metal particles in organic colloids and form highly reflective low melting temperature laser recordable media. Data are recorded by forming higher reflectivity spots which contrast with the surrounding field of the reflective layer itself. Reflectivity of the strip field of about 10% with a reflectivity of a spot in the field of more than 50% is preferred, thus creating a contrast ratio of at least five to one, although a contrast ratio of two to one or even lower may be sufficient for reading the data. Alternatively, media which have reduced reflectivity spots in a highly reflective field and media which are read by light transmission through the card may also be used.

Erasable, direct-read-after-write materials, such as magneto-optic and amorphous-to-crystalline recording materials, may also be used.

With reference to Figure 12, the data card 211 is shown to have been initialized, i.e. marked with start and stop marks 219 and 221 so as to demarcate the ends of the usable recording area 223. Once

initialized, a card writer/reader will not write data too close to a "stop" point for a given machine. The stop point is determined by the reading and writing optics of a card writer/reader and may vary for each machine type. Beyond the stop point, in areas 225 and 227, data writing is either impossible or subject to an unacceptably high level of read errors. In the event that the stop point for a particular card writer/reader is sufficiently large to be beyond an edge of the card, card initialization demarcates the effective edge of the card. The effective edge of the card need not be identical to the physical edge of the card. The smaller the distance between the data areas and the physical card edge, the more accurate must be the cutting of the card during production. Accurate cutting implies relatively sophisticated and expensive equipment in addition to a greater number of rejected cards. Accordingly, depending on the tolerances indicated for a particular type of card, the effective card edge may be set some distance away from the physical card edge.

The start and stop marks 219 and 221 are laser recorded as a series of lines across the narrow dimension of the cards. The marks can be continuous as shown or comprise dashed lines across each track. The prerecorded track lines 217 generally extend the length of the card 211. Initialization may be performed on a dedicated apparatus or on a data card writer/reader, such as the apparatus in Figure 17, with appropriate software. Each start and stop mark 219 and 221 may comprise one or a pair of parallel lines, as shown, or a series of lines in a predetermined pattern, as in Figure 13B. The pattern forms a code which when read indicates the location of data areas, i.e. where data are to be written or read. Alternatively, the pattern may indicate other information, such as the number of data sectors on a track or the particular data encoding scheme being used.

The position of the start and stop marks 219 and 221 corresponds to the stop points for a particular card writer/reader, with the edgemost lines in marks 219 and 221 preferably coinciding with the stop points. The marks thus define the user recordable area 223 therebetween and nonusable areas 225 and 227 between the start and stop marks 219 and 221 and their nearest card edge 226 and 228 respectively. On cards which are intended to be inserted in only one particular direction into a card writer/reader, a stop mark 221 need

not be recorded during initialization. Then the start mark 219 defines the user recordable area 223 between the mark 219 and the furthest edge 228. Appropriate track indicia may also be written during initialization or when the card is being recorded upon by the user.

Figure 12A shows an enlarged portion of the data card 211. The tracks 217 may be prerecorded either photolithographically, by laser recording, by moulding, or other means. One type of photolithographic prerecording involves exposing photosensitive material which is to form the strip 215 to actinic radiation through an imagewise pattern on a mask. The material is subsequently processed to form the strip 215 of laser recordable optical data storage material. One such photolithographic recording process is described in USA Patent Specifications Nos. 4 304 848 and 4 278 756. As mentioned above, the start and stop marks 219 and 221 are laser recorded across the narrow width of the card. As shown in Figure 12A, the start mark 219 forms a series of lines recorded crosswise over the prerecorded tracks.

The user recordable area 223 defined by the marks 219 contains laser recorded spots 229. The spots 229 represent data bits as well as track indicia, including but not limited to synchronization marks, error codes and track numbers. The spots 229 are generally greater than about 1 micron in size, preferably about 2 to 5 microns, but may be any size in the range from about 1 micron to 35 microns. The spots 229 may be either round or oblong and are typically recorded in paths between the tracks 217 with a separation dependent upon spot size and code scheme. The tracks 217 are also separated from each other by about 10 to 20 microns. Depending on the particular encoding scheme, bits may also be represented by the absence of spots, changes in spot size, shape or length and changes in spot reflectivity or transmissivity.

Returning to Figure 12, after the data card 211 is created it may be disposed in recording relationship with a laser recording apparatus, as shown in Figure 17. Track indicia and data 241 are written in at least one track in the user recordable area 223 of the strip 215. At a later time, the card 211 may be disposed in recording relationship with a second laser recording apparatus, which may or may not be the same as the first apparatus. Track indicia and data 242

are written on at least one unrecorded track in user recordable area 223. Track indicia and data 241 and 242 may be recorded in different encoding schemes by the first and second card writer/readers, although this is not essential. Writing of the track indicia and data 241 and 242 need not proceed in the same direction. For example, the first card writer/reader may write the data 241 in a first direction, such as a direction 230 proceeding from the edge 226 to the edge 228. The second card writer/reader may write the data 242 in a second direction, such as an opposite direction 232 proceeding from the edge 228 to the edge 226. Alternatively, the card writer/readers may write data in the same direction but with the card 211 oriented in opposite directions relative to the first and second card writer/readers. Relative to the card, the result is the same with data on the card being recorded in opposite directions. Further, when writing track indicia and data, tracks, defined between the track guides 217, may be numbered by one card writer/reader beginning with tracks nearest a top lateral edge 222 of the strip 215 toward tracks nearest a bottom lateral edge 224 of the strip 215, while another card writer/reader may number tracks from the bottom edge 224 towards the top edge 222. thus, in one or more of these manners, the same card may be used to store information from different industries or different machines. For example, the data 241 may be medical records of a person, while the data 242 on the same card may be medical insurance information of that person.

With reference to Figures 13A to 13C, a generic data card 211 containing prerecorded tracks 217 only is marked with start and stop marks 219 and 221 respectively. The marks 219 and 221 define a user recordable area 223 therebetween for recording track indicia codes 240 and data 241. The data 241 are recorded in one or more data areas, such as the area between dashed lines 224 and 226 in Figure 13C. The track indicia codes 240 include all marks which are laser recorded in the user recordable area 223 exclusive of data areas.

In Figure 13C, track indicia codes 240 include synchronization marks 231, track numbers 233 and 243, error codes 235, 237, 245 and 247 and sector numbers 239 and 249. the track numbers 233 are designated in Figure 13c by reference numerals 233a, 233b, 233c, 233d, and 233e, each representing a particular track number recorded on a

track. As already noted above, the start and stop marks 219 and 221 may be a series of lines recorded across the tracks 217 in a pattern representing a code. The code may indicate the location and number of data areas, the encoding scheme being used, and the like. Start and stop marks may alternatively be laser recorded spots which are written as the card is used. The start mark 219 is typically followed by the synchronization marks 231. The synchronization marks 231 typically comprise a plurality of equally spaced laser recorded spots, and serve to establish the location and spacing of laser recorded spots per track are shown in Figure 13c, the actual number may vary depending on the difficulty in achieving synchronization for a particular card writer/reader. The synchronization marks 231 may typically be from four to sixteen marks.

The track numbers 233 and 243 are recorded as data are written. Tracks without laser recorded track numbers have no data. A track number is used which is one higher than for the previous track. The previous track number may be obtained from reading the track number stored in a certain place on the card, such as immediately following the synchronization codes 231, or from reading the entire last written track. The number of bits used to specify a track number depends on the total number of tracks on a card. For example, a card with up to 128 tracks requires seven bit track numbers. As or after a track of data is written, it is read to verify that it has been correctly recorded. The error or "do-not-use" codes 235, 237, 245 or 247 is then written ahead of the track number or immediately after to indicate whether or not the data are correct.

In Figure 13C, three spot locations are dedicated to each "do-not-use" or error code. Each bit may be used to indicate a different type of error. For example, the first bit might be used to indicate a faulty track. Cards are typically prescanned at the point of manufacture or during initialization of a card. Good tracks are marked with a spot while defective tracks are not marked, or vice versa. Faulty tracks are not written on any further.

The second error bit might be used for data recording errors identified immediately after writing. If a data block is recorded with an acceptable error level it is rewritten and the cycle repeated as many times as permitted by the particular softward. A data block

is satisfactorily recorded with an acceptable error level when the detected level of recording errors is below a predetermined limit or percentage. In such cases, the same track number is used until a satisfactory data write is identified. Thus, regardless of the number of attempted track writings, sequential track numbers will represent only those verified as good tracks with correctly recorded data. In Figure 13C, the laser recorded spots between track lines 217a and 217b are assigned the track number 233a with a value of one and the error code 235 indicates that the data are correct. The next track, between track lines 217b and 217c, is assigned the next higher track number 233b with a value of two. Error code 237, however, indicates an unsatisfactory level of recording error. Accordingly, the same data block is recorded again on the next track, between track lines 217c and 217d. This track is assigned a track number 233c with the same value as track number 233b. The data in this track are recorded satisfactorily so the following track is assigned the next higher track number 233d with a value of three.

The third error bit can be reserved for the user's particular application. For example, it may function as a parity bit for checking the accuracy of future data reads. Additional error bits may also be used.

Data tracks can be and usually are divided into sectors. the number of sectors may vary depending on the application. Typically, there are between two and eight sectors per track. Track numbers 243 which correspond to track numbers 233a to 233d and error codes 245 and 247 are written after each sector. Sector numbers 239 and 249 identify each sector. Sectors permit shorter data blocks to be recorded, thereby decreasing the likelihood that a block will have an error and need to be rewritten. Sectors may also be provided for other design considerations, such as providing different sectors for various types of data. Further, when an error is detected, the data are written into the next sector instead of on a new track and an error code would be written indicating that the first sector is bad.

With reference to Figure 14, a method for writing data on a data card using a card writer/reader begins by advancing a data reading and writing element of the card writer/reader into proper relationship with the first unrecorded track on the card, and setting a register of

the card writer/reader to a track number. This first step may be performed as shown in Figure 15.

A data card is positioned in a card writer/reader and the data reading and writing element of the card writer/reader is advanced into reading and writing relationship with the first, i.e. edgemost track. The track number register of the card writer/reader is set to one. The track is scanned and the error code is read. If an error is indicated by the error code, the writing and reading element is advanced one track location to the next track. If no error is indicated, scanning continues in an attempt to find a recorded track number. If a track number is found, indicating a track which already has recorded data, the track number is registered and the reading and writing element is advanced on track location. This process continues until a track is found which has no indicated error and no recorded track number. This track is an unrecorded track available for writing data and the last registered track number is incremented by one. Other methods for finding an unrecorded track may be used.

Returning to Figure 14, after having located the first unrecorded track, the error code is read, and if a satisfactory track is indicated, the track is again scanned for defects. If an unacceptable level of defects is found, an error code is marked on the track indicating that fact. In either the case in which errors are indicated, i.e. by an error code or by a defect found during scanning, the card writer/reader advances to the next adjacent track location. If the track is satisfactory, the track number stored in the track number register of the card writer/reader is written in the current track on the card, and a data block is written in a data area on the track.

During or immediately following data recording, data and indicia actually recorded on the data card are checked against the original data base for recording errors. If unacceptable recording errors are found, the track is marked with an error code indicating the recording error, and the data block is saved in a temporary storage location so that it may be rewritten in another track location. If the recording is satisfactory, the card writer/reader checks to see if there is more data, and if so the data are written in additional track locations. Data recording continues until no more data remain to be recorded.

Data blocks may occupy an entire data area of a track. Alternatively, data may be recorded in sectors with several data blocks being recorded on a single track. Accordingly, if more data remain to be recorded on the card, the card writer/reader checks whether the end of the track has been reached. This will always be the case where large data blocks occupying an entire track are recorded, but will not necessarily be the case where data are recorded in sectors. If the end of the track has not been reached, the track number and other indicia are written followed by the next data block. If the end of the track has been reached, the track number is incremented, the reading and writing element of the card writer/reader is advanced one track location so as to be in reading and writing relationship with the next track, and the error code checking procedure is repeated, as noted above for the previous track, with the new track.

When an unacceptable level of recording error has been detected, the data block which is saved may be rerecorded either on a new track or in a new sector depending on the particular data writing software that is used. Typically, the data block is rewritten on a new track when large data blocks occupying entire tracks are recorded and the data block is rewritten in a new sector when data blocks are recorded in sectors. However, data blocks may also be rewritten on a new track where data blocks are recorded in sectors. In any case, if rerecording is to be done on a new track, the reading and writing element is advanced one track location without incrementing the track number. thus, track numbers indicate in this case, only those tracks verified as having good data. If data are rewritten in sectors, the card writer/reader checks whether the end of the track has been reached, if not, then writing the track number and other indicia and rewriting the data block. If the end of the track has been reached, the track number is incremented, the track location advanced to an adjacent track, and the data block including indicia rewritten in a sector on the new track.

With reference to Figure 16, when a card is manufactured, all tracks may be scanned for defects. First, a card is created with prerecorded tracks, as described above with reference to Figure 11. The card may be checked in either a dedicated machine or a card

writer/reader. Advancing into reading and writing relationship with the first track, i.e. an edgemost track, the track is scanned. If unacceptable defects are found, the track is marked with an error code indicating that defect. Advancing to the next track, the scanning is repeated until there are no more tracks remaining to be scanned. The number of defective tracks may be counted, if desired, and the card rejected if the number of defective tracks exceeds a preset amount.

With reference to Figure 17, a side view of the lengthwise dimension of a data card 251 is shown. The card is usually received in a movable holder 253 of the card writer/reader in a position which brings the card into the beam trajectory. The card writer/reader includes a laser light source 255, preferably a pulsed semiconductor laser of near infrared wavelength. The laser 255 emits a beam 257 which pases through collimating and focussing optics 259. The beam is sampled by a beam splitter 261 which transmits a portion of the beam to a photodetector 263. The detector 263 confirms laser writing and is not essential. The beam is then directed to a first servo controlled mirror 265 which is mounted for rotation along the axis 267 in the direction indicated by the arrows A. The purpose of the mirror 265 is to find the lateral edges of the laser recording material in a coarse mode of operation and then in a fine mode of operation identify data paths which exist predetermined distances from the edges.

From the mirror 265, the beam is directed towards a mirror 269. The mirror 269 is mounted for rotation at a pivot 271. From the mirror 269, the beam is directed towards the card 251 in a lengthwise scanning motion. Light is focussed into the card by a focussing lens 277. The purpose of the mirror 265 is for fine control of motion of the beam along the length of the card. Coarse control of the lenthwise position of the card relative to the beam is achieved by motion of the movable holder 253, as indicated by double arrow C. the position of the holder 253 may be established by a linear motor adjusted by a closed loop position servo system of the type used in magnetic disc drives. During its manufacture the card is prerecorded with a preinscribed pattern containing servo tracks. These positioning marks can be used as as reference for the laser recording along data tracks. Position error signals may be generated and used

as feedback in motor control. Data regarding a card holder may also be prerecorded.

Upon reading one data path, the mirror 265 is slightly rotated. The motor moves the holder 253 lengthwise so that the path can be read, and so on. Light scattered and reflected from the spots contrasts with the surrounding field where no spots exist. The writing beam should deliver sufficient laser pulse energy to the surface of the recording material to create spots. Typically, 5-20 milliwatts of laser power is required, depending on the recording material. A 20 milliwatt semiconductor laser, focussed to a five micron beam size, records at temperatures of about 200°C. and is capable of creating spots in less than 25 microseconds. The wavelength of the laser should be compatible with the recording material. In the read mode, power is lowered to about 5% of the record power. Alternatively, a second light source 279, preferably a light emitting diode, may be used to generate a reading beam 280. The beam 280 passes through collimating and focussing optics 281 and is deflected onto the main beam path by a beam splitter 283.

Optical contrast between a spot and surrounding field are detected by a light detector 275 which may be a photodiode. Light is focussed onto the detector 275 by a beam splitter 273 and a focusing lens 274. Servo motors, not shown, control the positions of the mirrors and drive the mirrors in accordance with instructions received from control circuits, as well as from feedback devices. The detector 275 produces electrical signals corresponding to spots. These signals are processed and recorded for error checking and reading data.

The card described herein may be used by different industries which have formatting specific to their own needs. Track indicia codes allow the user to specify his specific formatting such as machine dependent user recordable areas, data areas, laser recorded spot spacing, encoding schemes and the like: A card contains a picture on one side and machine readable information on the opposite side, with the two pieces related to the card holder. Alternatively the picture could be read on the same side as the machine readable information by seeing through a transparent card portion. In this situation the picture is offset from the machine readable information. Large numbers of distinct cards may be made by the methods described

herein.

CLAIMS

1. A method of forming a wallet size data card comprising, reproducing a plurality of visible images on a first web from a roll, the first web having a front side, a back side and a width dimension not exceeding the width dimension of a wallet size card, the length of the visible image not exceeding the length dimension of a wallet size card,
forming a second web from a roll of high resolution laser optical recording tape containing servo tracks or data location grids, the second web having a front side, a back side and a width dimension,
joining the first web to the second web with one side of the first web proximate to a corresponding side of the second web, and
cutting the joined web at intervals along the lengthwise dimension thereof into a plurality of wallet size cards, each card having a visible image and optical recording tape.

2. A method according to claim 1, wherein the backside of the first web is joined proximate to the backside of the second web whereby the joined webs can be read from opposite sides.

3. A method according to claim 1, wherein the front side of one web is proximate to the back side of the other web with visible images and data laterally optically adjacent wherein optical images and optical data are read from the same side of the card.

4. A method according to claim 2, further comprising producing visible images on the first web by means of laser scanning of photographic emulsion with picture information thereby producing latent images and then developing the latent images prior to joining the first web to the second web.

5. A method according to claim 4, further comprising writing bar code latent image indicia onto the emulsion at the time the picture latent images are formed with the laser.

6. A method according to claim 5, further comprising scanning the

optical recording tape of each card for defects and correlating a defective card with the bar code indicia.

7. A method according to claim 6, further comprising repeating the reproducing of a visible image on another web corresponding to the visible image of a defective card and joining the visible image web to a portion of optical recording tape in a relation similar to the defective card thereby forming a new card.

8. A method of forming a wallet size data card comprising,
writing a succession of latent images containing picture information with a scanning laser onto a first elongate web of photosensitive film, the first web having a front side and a back side,
advancing the web and developing the latent images into a succession of eye readable pictures,
joining a second elongate web of high resolution laser optical recording tape with the first web, the second web having a front side and a back side, the two webs being jointed with one side of the first web proximate to a corresponding side of a second web, thereby forming a composite web, and
cutting the composite web transversely into lengths forming wallet size cards, each card having an eye readable picture portion and an optical recording tape portion.

9. A method according to claim 8, wherein the backside of the first web is joined proximate to the backside of the second web whereby the joined webs can be read from opposite sides.

10. A method according to claim 8, wherein the front side of the first web is proximate to the front side of the second web with visible images laterally adjacent laser optical recording material wherein optical images and optical data are read from the same side of the card.

11. A method according to claim 8, further comprising producing visible images on the first web by means of laser scanning of photographic emulsion with picture information thereby producing

latent images and then developing the latent images prior to joining the first web to the second web.

12. A method according to claim 8, further comprising writing bar code latent image indicia onto the emulsion at the time the picture latent images are formed with the laser.

13. A method according to claim 12, further comprising scanning the optical recording tape of each card for defects and correlating a defective card with the bar code indicia.

14. A data card comprising,
a card substrate having front and back opposed major surfaces and a length and width comparable to wallet size bank cards,
a high resolution DRAW optical recording material applied to a first surface portion of the card,
a recording medium carrying a visible image applied to a second surface portion of the card, and
a low resolution machine readable scanner coding strip applied to a third surface portion.

15. A data card according to claim 14, wherein the optical recording material and the visible image face on the same side of the card.

16. A data card according to claim 13, wherein the optical recording material and the visible image face on opposite sides of the card.

17. A data card according to claim 14, wherein the scanner coding strip comprises a bar code strip.

18. A data card according to claim 14, wherein the scanner coding strip comprises a magnetic strip.

19. A method of forming a wallet sized data card as claimed in claim 1 or claim 8 and substantially as hereinbefore described.

20. A data card substantially as hereinbefore described and

illustrated with reference to the accompanying drawings.